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Todd Thompson
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State Water Resources Control Board
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Dear Mr. Thompson:

I am Ralph L. Phillips and have worked for the University of California as a farm advisor in Kern County since 1980. My academic training includes a Ph.D. in Ruminant Nutrition from Oregon State University, a M.S. in Toxicology and a B.S. in Animal Science from Utah State University. I worked on an Oregon State University Experiment Station for six years before moving to California, where I conducted research involving selenium and molybdenum metabolism in beef cattle and sheep.

While in California, I have conducted 10 years of research on selenium and molybdenum in the environment and their impact on the nutritive value of alfalfa hay and range forages for beef cattle and sheep. I cooperated with Dr. Roland D. Meyer, a soil fertility-plant nutrition specialist at the University of California, Davis. Dr. Meyer provided the expertise in the soil and plant area of the study and I provided the expertise in the area of forage nutrition and beef cattle requirements. 12-1

For the past three years, I have been cooperating with Dr. Edward Atwill, an environmental animal health researcher with the University of California School of Veterinary Medicine.

After reading the Draft Environmental Impact Report for Biosolids Land Application, I would like to respond to two areas of the report. The first area is Chapter 4, Land Productivity, Pages 4-11.

In ruminant nutrition, there is a copper - molybdenum - sulfur interaction that can have a big economic impact on the livestock industry under certain conditions. Cameron and Goss (1948) and Parker (1952) demonstrated that a high level of molybdenum in alfalfa hay was causing serious health problems for beef cattle grazing forages or consuming alfalfa hay grown on the valley floor. Parker noted that the severe cases were associated with alkaline clay soils. Since this early work, science has found that molybdenum is antagonist toward copper. Also, it has been shown that alfalfa and other legumes accumulate higher levels of molybdenum than other plant families. To further complement the situation, sulfur concentrations can influence the molybdenum and copper complex. 12-2

As a rule of thumb, feed with three or more parts per million molybdenum are considered a health

risk. However, evaluating the health risk of forages to cattle is very complicated when interpreting the three way interaction between copper, molybdenum and sulfur. Also, the ratio of copper to molybdenum must be considered. A 2:1 ratio of copper to molybdenum is considered safe to feed unless there is excess sulfur, then there is a potential of animal health problems.

Parker's work showed that less than three percent of alfalfa samples taken in 1950, contained less than three parts per million, about 45 percent contained 3:1-10:0 parts per million molybdenum, about 50 percent contained 10:1-20:0 parts per million, and about two percent contained 20:1-50:0 parts per million molybdenum.

In 1985, Phillips and Meyer (1993) took alfalfa samples from the same areas of Kern County that Parker had sampled and found that about 45 percent of the alfalfa contained less than three parts per million molybdenum. The remaining 55 percent contained 3:01-10:0 parts per million molybdenum.

Also, they ranked the alfalfa samples as to potential nutritional problems for ruminant animals. Based on the molybdenum and copper concentrations and their ratios, they showed that over 20 percent of the samples would probably cause nutritional problems in cattle and sheep if their diets were not supplemented with copper. Another 24 plus percent of the samples had a potential problem if animals did not receive a copper supplement. 12-2 (cont)

This work demonstrates that progress has been made over the past 35 years in improving the nutritional value of alfalfa hay regarding concentrations of molybdenum. However, no work has been done in Kern County to address the sulfur levels in relation to molybdenum and copper. Phillips and Meyer (1993) evaluated potential problems related to copper and molybdenum interaction, but did not evaluate the concentration of sulfur in the interaction of the three minerals. However, their data does show there is a potential for nutritional problems in about 50% of the hay sampled if it were fed to cattle not receiving a copper supplement.

Phillips and Meyer (1993), showed there was not a geographic pattern for the distribution of copper, molybdenum or sulfur. This creates an expense for livestock producers. They must have forages tested for minerals, supplement for minerals or accept reduced livestock performance because of the mineral imbalance.

The addition of biosolids to Kern County soils has a good chance of reversing the 35 year trend of lower molybdenum concentrations in alfalfa hay grown in Kern County.

Dr. Meyer, in his personal comments, stated that adding very small amounts of molybdenum increased the levels in alfalfa hay.

Most of the federal EPA's report on safety of biosolids does not address molybdenum in western U.S. soils. It would be wise to talk to people like Dr. Meyers, who have done considerable work in this area and understands the soil-plant-animal relationship before this EIR is approved.

12-2 (cont)

The second point of concern regarding the Draft Biosolids EIR is on Page 5-14: "Transport of bacteria, viruses and other pathogens by air or by aerial vector such as insects and birds has been hypothesized." Work done in Kern County by Dr. Edward Atwill and Ralph L. Phillips, would indicate that feral hogs, coyotes, squirrels, rats and cattle, could be vectors for *Cryptosporidium parvum* and *Giardia duodenalis* and should be added to the list of potential vectors of waterborne protozoan.(Table 1).

LEVELS OF INFECTION

	C. parvum	*G. duodenalis*
Cattle (Atwill, et.al. 1999)		
One year or older	0.6%	7%
Calves less than one year	6%	37%
Trail and Pack Horses (Johnson, et.al., 1997)	0	0
Feral Hogs		
Less than eight months (Atwill, et.al., 1997)	11%	6%
More than nine months	3%	8%
*Coyotes	22%	43%
*Squirrels	16%	16%
*Rats	5%	21%

*Unpublished data

12-3

Atwill's work has not studied the link between wildlife and humans or the link between biosolids and wildlife, but clearly demonstrated that certain mammalian wildlife species can carry the same pathogens found in humans and biosolids.

Kinde (1996) studied the movement of *Salmonella enteritidis,* in the environment. He demonstrated the movement of *S. entiritidis* from the sewage effluent to rodents along the banks of the effluent stream. He later isolated the same organism from eggs from a chicken ranch in the area. He is convinced that he has shown a link from the sewage industry to the human food chain. His peered reviewed articles on the topic would support his beliefs.

Kinde's and Atwill's work would push the transport of microorganisms by vectors away from hypothesis and much closer to reality.

12-3 (cont)

The EIR for biosolids land application needs a deeper review of the current and past research in the areas discussed in this letter. The EIR is not complete enough to ensure public safety at this time.

References

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Sincerely,

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Range/Natural Resources and Livestock Advisor
Kern and Tulare Counties

RLP:cr
cc: Bernard C. Barmann

Responses to Comments from the Kern County - University of California Cooperative Extension

12-1. This comment is in regards to the commenter's qualifications. No response is necessary.

12-2. The commenter raises concern that addition of biosolids containing molybdenum (Mo) can cause molybdenum toxicity (molybdenosis) in grazing animals fed from hay containing elevated levels of Mo. As noted in the detailed and informative letter, and its accompanying references, this is a concern in large parts of Kern County where native soils contain elevated concentrations of Mo. Consequently, feed grown on these soils also can contain Mo levels that are potentially harmful to animal health. Biosolid additions, where the biosolids contain appreciable levels of Mo, could increase the problem. The commenter also provides information and references that molybdenum toxicity and nutrition is a complex issue, and is related to levels of copper and sulfur in the soil and forage crops, which interact to influence the mineral nutrition of animals. The commenter does not believe that the Part 503 regulations adequately addressed this concern. Since the cumulative loading rates for soils in the proposed GO for Mo is largely based on the Part 503 regulations, the commenter concluded that this issue needs further analysis and discussion in the EIR.

Molybedenum toxicity was briefly discussed in Chapters 3 and 4 of the draft EIR; however, it was concluded on page 4-12 that "the combination of circumstances that could lead to grazing animal toxicity following biosolids applications with elevated levels of trace metals . . . were remote." The information in the commenter's letter has become part of the final EIR and adds greatly to the understanding and discussion of this issue. How remote the chance of grazing animal health impact would be, particularly when viewed from a statewide perspective, is a subjective determination. The SWRCB staff agrees with this comment; it appears to be a potential threat in Kern County in areas of high native Mo, where elevated Mo biosolids (but nevertheless below ceiling limits) were to be applied to these lands. Similarly it was acknowledged in the draft EIR that biosolids containing selenium (Se) in elevated levels but below ceiling limits, could also potentially cause toxicity problems in soils high in native Se, such as that on the west side of the San Joaquin Valley.

But, these acknowledgments do not significantly change the draft EIR's findings and mitigation recommendations, as potential grazing animal toxicity was determined to be a potentially significant impact. Please note that the Pre-Application Report (Appendix A) requires that native soils be tested for a range of elements that are potentially toxic or essential to the mineral nutrition of plants and grazing animals. Testing of biosolids for this same suite of elements, including Mo and Se, is also required. Mitigation Measure 4-1 requires that waste discharge requirements applicants provide information on soils that allows RWQCB staff to consider, in a comprehensive fashion, the nutrients and mineral

elements applied to a biosolids application site, considering native soil conditions and crops.

The Part 503 regulations only specifically require consideration of nitrogen from an agronomic perspective. SWRCB staff believes that implementing this mitigation measure, specifically in cases where regulators and applicators are alerted to the potential Mo problem in Kern County (as they are), will also be effective in precluding the type of animal mineral toxicity and mineral deficiency problems that might otherwise occur. The continued involvement and assistance of UC Cooperative Extension, which was acknowledged in the draft EIR section, will also be essential to management of grazing lands and grazing animals to avoid the type of potential toxicity and mineral deficiency or imbalance problems identified.

Mitigation Measure 4-1, which requires comprehensive testing of soils and biosolids and analysis of potential fertility (and toxicity) problems, is not specifically referred to under the impact heading "Changes in Grazing-Land Productivity." Therefore, the following text is added to the end of Mitigation Measure 4-2 on page 4-12 of the draft EIR:

> Refer also to Mitigation Measure 4-1, which requires comprehensive testing and analysis of soils and biosolids by qualified professionals.

Additionally, to strengthen this mitigation measure and its applicability to the grazing land productivity issue, the first paragraph of Mitigation Measure 4-1 on page 4-5 is revised as follows:

> The GO Pre-Application report.....2) metals related phytotoxicity does not occur, 3) metals related forage toxicity or mineral deficiencies and other trace metals related problems do not occur on hay lands and pasture lands, 4) increases in salinity.....

As presented in the draft EIR, Mitigation Measure 4-1 was written such that the applicant, an agronomist, or a soil scientist are all able to make the determination as to whether biosolids applications will impact soil and grazing land productivity (see page 4-5, third paragraph). Some of the issues regarding metals bioavailability and mobility and nutrient and metal interactions in different soil environments and for different crops, and regarding animal nutrition may be beyond the capabilities and experience of many applicators. Accordingly, the third paragraph of Mitigation Measure 4-1 is revised as follows to eliminate the "applicant" from those qualified to perform the analysis, unless of course the applicant is also a qualified soil scientist or agronomist:

> This information should be used by a certified soil scientist, or a certified agronomist to evaluate the above potential effects on land productivity. The soil scientist and/or agronomist should make recommendations in a letter report to accompany the Pre-Application report regarding the proper rate of biosolids

applications, any soil management (such as supplemental fertilizers and pH adjustment), appropriate crop, and grazing practice recommendations, considering the nature of the application site soils and biosolids characterization data, and the need to preserve short term and long term land productivity.

Also see Response to Comment 26-32.

12-3. Comment is regarding the statement made on page 5-14 of the draft EIR, where it is stated that "Transport of bacteria, viruses and other pathogens by air or by aerial vector such as insects and birds has been hypothesized." The Commenter provided information on recent research showing that feral hogs, coyotes, squirrels, rats and cattle could be vectors of *Cryptosporidium parvum* and *Giardia duodenalis* and should be added to the list of potential vectors of waterborne protozoans.

Table 5-3, column 3, entitled Nonhuman Reservoir is amended to include the following vectors for the human pathogens Cryptosporidium: feral hogs, coyotes, squirrels and rats ; and *Giardia* spp.: cattle, feral hogs, coyotes, squirrels and rats.

Addition of this information makes no change in the previous conclusions regarding impacts to public health nor a change in any proposed mitigation measures.

The unpublished research work cited does not link these two pathogenic protozoans with wildlife exposure to biosolids or provide any linkage between these wildlife species and human exposure to the organisms or their feces. However, the commenter notes the work of Kinde (1996) cited in the draft EIR on page E-5 about the link between a salmonella outbreak among chickens and wastewater effluents in a nearby stream that might have been transmitted by rodents.

The commenter notes that "The EIR is not complete enough to ensure public safety at this time" and indicates a desire to have "a deeper review of the current and past research in the areas discussed in this letter."

The reader is referred to Appendix E of the draft EIR (see Appendix B of this final EIR) for the requested discussions of pathogens and public health concerns, which was intended to go into more detail and expand on the information presented in draft EIR Chapter 5.